# Petrology of the High-Alumina Hoosac Schist from the Chloritoid+Garnet Through the Kyanite+Biotite Zones in Western Massachusetts

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# PETROLOGY OF THE HIGH-ALUMINA HOOSAC SCHIST FROM THE CHLORITOID+GARNET THROUGH THE KYANITE+BIOTITE ZONES IN WESTERN MASSACHUSETTS[1]

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## INTRODUCTION

The eastern limb of the Berkshire anticlinorium of western Massachusetts (Figure 1) is a complex, multiply-deformed, polymetamorphic, Taconian/Acadian orogenic terrane. The geologic framework of this area is well established, originally by the mapping of B.K. Emerson (1892, 1898, 1899) and Pumpelly *et al.* (1894), as summarized on the Massachusetts geologic map of Emerson (1917), and more recently by the mapping of L.M. Hall, N.L. Hatch, S.A. Norton, P.H. Osberg, N.M. Ratcliffe, and R.S. Stanley, as summarized on the Massachusetts geologic map of Zen *et al.* (1983). The summary reports of USGS Professional Paper 1366 in 1988 as well as the work of Hatch *et al.* (1984), Stanley and Ratcliffe (1985), and Sutter *et al.* (1985), among others, provide a provocative regional synthesis that brings into sharp focus a variety of interrelated structural, stratigraphic, petrologic, and geochronologic problems.

Despite vigorous efforts, our ability to constrain the timing of many fundamental events is still hampered by both the complexity of the terrane and a lack of data. As reviewed by Karabinos and Laird (1988), differentiating between the effects of different metamorphic events remains quite problematic in much of the terrane. The recent work of Hames *et al.* (1991) and Armstrong *et al.* (1992) emphasizes the problem of differentiating between Taconian and Acadian orogenic effects along the zone of maximum overlap, which generally coincides with the axis of the Berkshire massif. This field trip (see figure 10 for route) will review the nature of this polymetamorphism in a nearly continuous belt of high-alumina, Gassetts-like schists of the Hoosac formation that occurs along the eastern margin of the Berkshire massif. As a bonus we will have the opportunity to examine the nearly continuous prograde metamorphic evolution of a relatively unusual, but mineralogically interesting, bulk composition that has historically received much attention.

## REGIONAL SETTING

The Berkshire massif consists of “nested thrust slices” of Middle Proterozoic (~1 Ga), “Grenvillian”, metamorphosed sedimentary, granitic, and volcanic gneisses and their unconformable cover rocks of the Cambrian Dalton Formation (Ratcliffe *et al.*, 1988). The antiformal structure of the Berkshire massif results from Acadian folding of Proterozoic to Lower/Middle Devonian age rocks that manifest a variety of stratigraphic, metamorphic facies, and structural relationships produced in part by the older Taconian orogeny (Robinson, 1986). As shown on the Bedrock Geologic Map of Massachusetts (Zen *et al.*, 1983), summarized by Hatch *et al.* (1984) and shown on Figure 2, the Berkshire massif and its eastern cover sequence can be represented by three lithotectonic assemblages: the Taconic-Berkshire Zone, the Rowe-Hawley Zone, and the Bronson Hill Zone.

The Taconic-Berkshire Zone includes an allochthon of ~1 Ga basement gneisses of the North American craton. West of this allochthon are autochthonous basal clastic rocks that rest unconformably on this same basement and that are succeeded by Cambrian to Lower Ordovician carbonate bank deposits. These miogeoclinal rocks are overlain by allochthonous Cambrian to pre-Middle-Ordovician clastic sediments and minor volcanic rocks of the Taconic allochthons. The Taconic allochthons are thought by Stanley and Ratcliffe (1985) to be the eastern facies of the autochthonous section and, thus, to have been transported from east of the continental basement. The Late Proterozoic to Lower Cambrian Hoosac Formation is believed to be a “western facies,” equivalent to some of the allochthonous section, but remains east of the Berkshire massif where it is in fault contact with basement gneisses along the Middlefield-Hoosac Summit thrust (Stanley and Ratcliffe, 1985).

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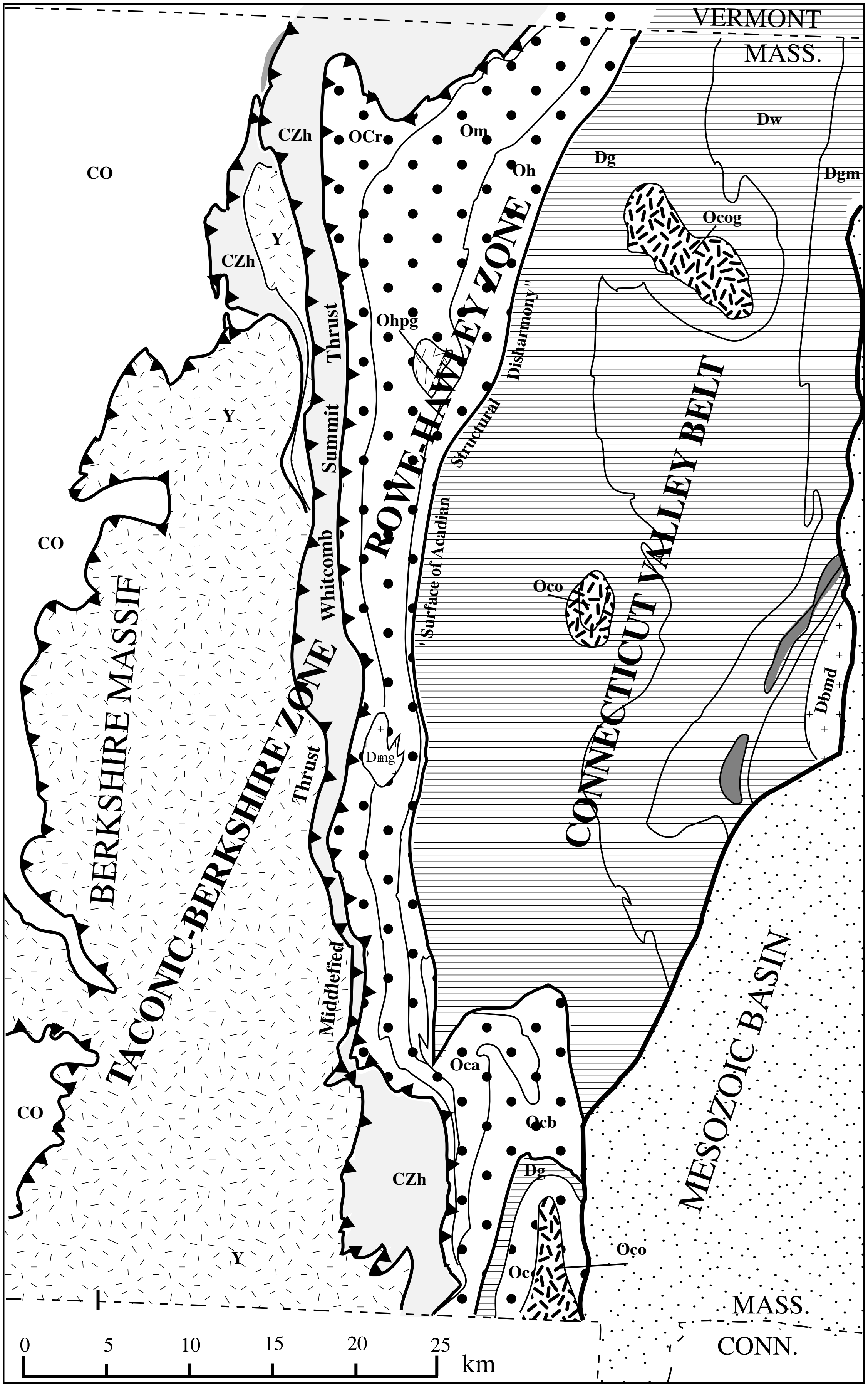


**FIGURE 1.** Generalized geologic map of the Berkshire massif, modified from Zen *et al*.(1983). The map symbols are as shown on the State Map of Massachusetts, see Zen *et al*.(1983) for details.

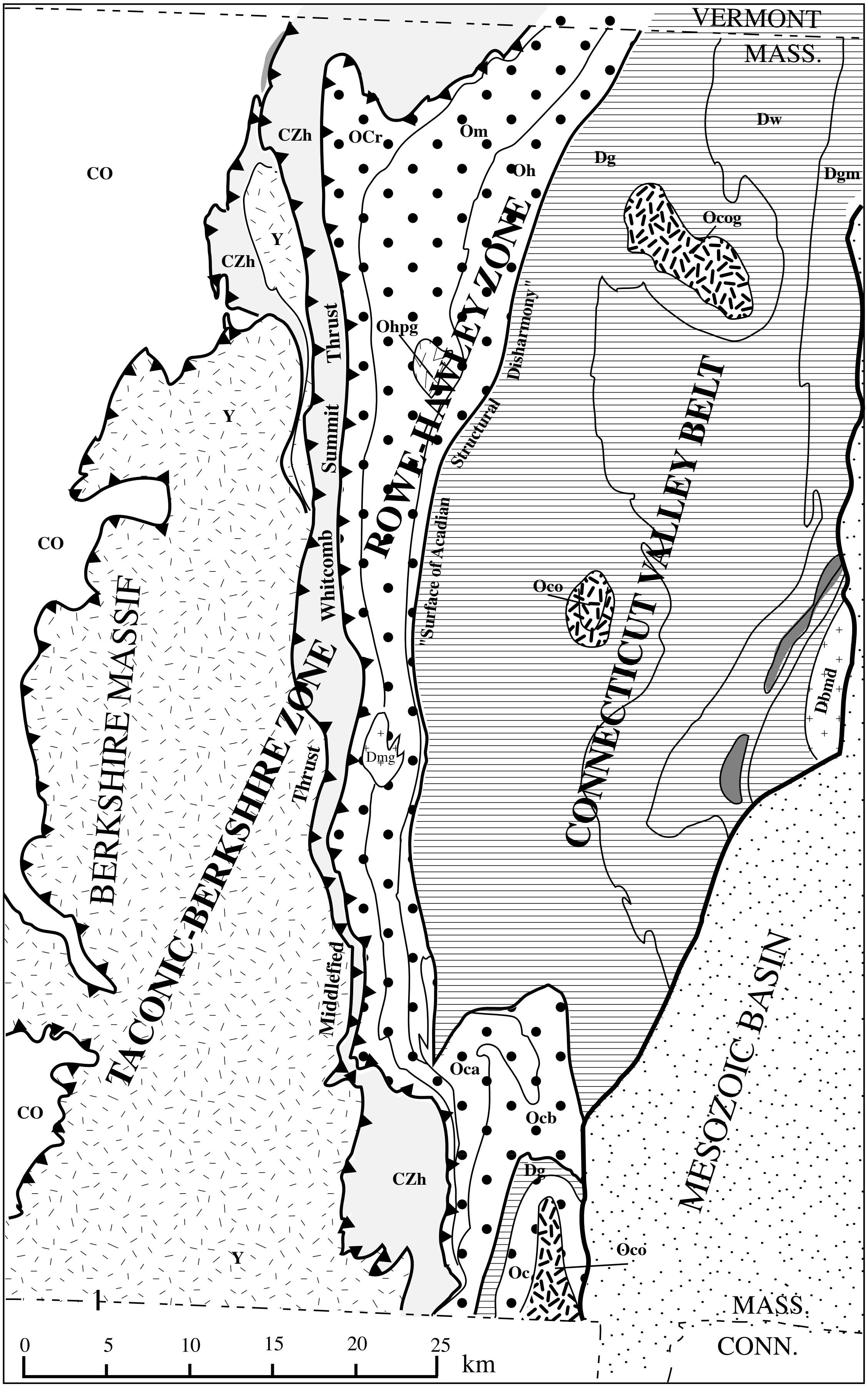


**FIGURE 1.** Generalized geologic map of the Berkshire massif, modified from Zen *et al*.(1983). The map symbols are as shown on the State Map of Massachusetts, see Zen *et al*.(1983) for details.

The Hoosac Formation, regarded by Stanley and Ratcliff (1985) as the source of the Taconic allochthons, is separated from Cambrian to Ordovician rocks of the Rowe-Hawley Zone by the Whitcomb Summit thrust of Taconian age. This fault is interpreted as the northern extension of Cameron's line in Connecticut. It separates the Hoosac Formation to the west, originally deposited upon Grenvillian age continental basement, from rocks of the Rowe, Moretown, and Hawley (or Cobble Mountain) Formations to the east, probably deposited upon oceanic crust (Hall and Robinson, 1982; Zen *et al*., 1983). As developed by Stanley and Hatch (1988), the "Whitcomb Summit thrust carries the Rowe-Hawley Zone over the root zone of the Taconic allochthons." Hatch and Stanley (1988) have interpreted the Rowe Schist as a complex tectonite zone with displacements along internal thrusts of the same magnitude (tens to hundreds of kilometers) as estimated for the Whitcomb Summit and the Middlefield thrusts.

The border of the Rowe-Hawley Zone with the Bronson Hill Zone to the east is covered by the Silurian-Devonian Connecticut Valley Belt. The contact between the Hawley Formation to the west and the Goshen Formation of the Connecticut Valley Belt (locally called the RMC) is interpreted as a "surface of Acadian structural disharmony" (Hatch *et al*., 1988), although other interpretations have been entertained (see Hatch and Stanley, 1988). The concealed contact between the Rowe-Hawley Zone and the Bronson Hill Zone is the "upper surface of the east dipping subduction zone along which the Iapetus ocean disappeared beneath the Bronson Hill plate" (Hatch *et al*., 1984).

The Taconian and Acadian events that assembled the package of rocks now comprising the east limb of the Berkshire massif have imparted a complex structure to the area and a complex fabric to these rocks. A detailed Taconian-Acadian orogenic history has been established that includes up to five stages of folding and multiple pulses of metamorphism expressed by differential mineral growth relative to the resulting fabrics (Hatch, 1975; Norton 1975a,b; Stanley, 1975; Stanley and Hatch, 1988; Ratcliffe *et al*., 1988). At least three distinct generations of folds are present in post-Taconian rocks and thus must be Acadian (Hatch and Stanley, 1988). The Acadian folding is time transgressive, especially along the north to south axis of the orogen. Although the intensity of Acadian deformation and associated schistosity diminishes to the west, Acadian fabrics clearly overprint and dominate Taconian fabrics at least to the western edge of the Rowe-Hawley Zone. In the Rowe Schist and Hoosac Formation the dominant schistosity is parallel or sub-parallel to Taconian age schistosity traced eastward from the Taconic-Berkshire Zone (Hatch and Stanley, 1988; Ratcliffe *et al*., 1988). However, as reviewed by Hames *et al*. (1991) and Armstrong *et al*. (1992), Acadian folding is present well to the west of the Whitcomb Summit thrust and, indeed, to the west of the Berkshire massif.

Similarly, there is considerable uncertainty in the age of metamorphism and extent of polymetamorphism affecting the Cambrian-Ordovician rocks. In particular, the western extent of Acadian fabric development and mineral growth is difficult to ascertain and the separation of Acadian-dominant vs Taconian-dominant metamorphism has not been documented in detail. Karabinos and Laird (1988) point out that the uncertainty in the time of metamorphism is due to conflicting age dates, ambiguous rock fabrics, and the complex metamorphic/tectonic history of the area. However, recent geochronologic studies of Sutter *et al*. (1985) and Hames *et al*. (1991) have generally confirmed the overprint pattern shown on the Metamorphic Map of Massachusetts (Zen *et al*., 1983). Specifically, the Acadian-dominant boundary seems to be within the Berkshire massif, west of the Whitcomb Summit thrust (Cameron's line), and perhaps even west of the Middlefield-Hoosac Mountain thrust.

## METAMORPHISM

The distribution of metamorphic isograds as shown on the Metamorphic Map of Massachusetts (Zen *et al*., 1983) obscures the complex nature of the metamorphism resulting from the events chronicled above. As originally described by Hatch (1975), Norton (1975a), Hatch and Stanley (1976), and reviewed by Hatch and Stanley (1988), there has been some difficulty in mapping consistent metamorphic isograds across structural/stratigraphic contacts in the east limb of the Berkshire massif.

Figure 2 is a metamorphic map for the east limb of the Berkshire massif. An earlier version of this map was used in the compilation of the Metamorphic Map of Massachusetts (Zen *et al*., 1983). Figure 2, based upon petrographic descriptions of over 2000 thin sections, represents results from ongoing, detailed petrographic studies aimed at refining our understanding of the complex sequence of tectonic/metamorphic events in this polygenetic terrane. Much of this work has been done by seniors at Amherst College as honors theses or independent study projects. These field-oriented, petrographic studies by undergraduate students combined with the studies of of Abbott (1979),Downie (1975, 1979) and Pferd (1981) have been instrumental in building on earlier work to locate in detail several of the isograds shown on Figure 2. These isograds include: (1) the St+Bio isograd within the Hoosac, Moretown, and western portion of the Goshen Formations (Sander, 1977), (2) the Ky+Bio and St+Bio isograds in the Goshen (Dibble, 1981), Ashfield (Hudson, 1983), and Colrain (Pferd, 1981; Goeldner, 1983) Quadrangles, and (3) the "Sillimanite isograd" in the Hoosac Formation (Bryan, 1978). In addition, these studies and those of Conner (1979) in the Westhampton Quadrangle, Britt (1980) in West Granville, Cohan (1980) and Handy (1980) in Woronoco, Hickmott (1982) in Worthington, and Maggs (1984) in South Sandisfield have expanded coverage of the large area comprising the east limb of the Berkshire massif.

As shown on Figure 2, the east-west trending St+Bio and further south Ky+Bi isograds established during bedrock mapping (see Zen *et al*., 1983 for references) are difficult to trace across and are conceivably offset along the north-south trending RMC (Taconic Line) and Whitcomb Summit thrust faults. These structural discontinuities separate Cambrian-Ordovician units from the older Hoosac and younger Goshen Formations. The resulting pattern of apparent metamorphic grades consists of a north-south-trending Gar+Cht Zone "core" comprised of the Rowe, Moretown and Hawley Formations that is flanked by successively higher grade rocks, from north to south, of the Hoosac and Goshen Formations. Approximately 20 km south of the Ky+Bio isograds mapped in the flanking units, the transition from Gar+Cht Zone to Ky+Bio Zone occurs within the "barren core" over a short distance of 1-2 km. The initial occurrences of staurolite and kyanite within these barren units are "so complexly distributed that consistent isograds could not be mapped" (Hatch and Stanley, 1976).

Post metamorphic faulting might explain the differential nature of apparent metamorphic grade characterizing various stratigraphic portions of the terrane including the apparently offset isograds. However, a more plausible explanation for these complexities and the resulting map pattern is based upon the effect of spessartine and grossular components of garnet on the AFM discontinuous reaction Gar+Cht = St+Bio. All available mineral assemblage and analytical data are generally consistent with a model, described by Cheney *et al.* (1980), that involves differential stabilization of the Gar+Cht join by the spessartine and/or grossular components in garnet (Figure 3). Specifically, the near-rim analytical sum CaO+MnO is systematically higher in garnets from the Cambrian-Ordovician "barren core" (Rowe, Moretown, and Hawley Formations) relative to garnets from the flanking Hoosac and Goshen Formations (Figure 4). As shown (Figure 3) by the biotite projections of Cheney *et al.* (1980; see also Spear and Cheney, 1989), the addition of MnO and/or CaO causes the AFM discontinuous reaction Gar+Cht = St+Bio to become a continuous reaction. Thus, in rocks containing MnO+CaO-richer garnet, the coexistence of staurolite with biotite should not occur until higher temperatures are reached. Assuming that the observed concentration of these extra components in the garnet rims is proportional to the increased temperature of the isograd reaction, the St+Bio isograd should occur at lowest grade in the Goshen and Hoosac Formations and at higher grades in the "barren core." These results are consistent with similar conclusions based on different approaches of Hatch and Stanley (1988), Sutter and Hatch (1985) in Massachusetts, and Laird *et al.* (1991) in southern Vermont.

Sources of uncertainty in this interpretation include the relatively small sample population, the extreme compositional zoning characteristic of most garnets, and the uncertain status of chlorite in many rocks. An additional complexity pertaining to the significance of metamorphic isograds in this terrane is the uncertainty in the extent of polymetamorphism and age of metamorphism affecting even the Silurian-Devonian rocks in this area. As pointed out by Sander (1977), Abbott (1979), Pferd (1981), and others, the Garnet, Staurolite and Kyanite isograds are multiple-event phenomena as indicated, for example, by initial occurrences of garnet, and at higher grade staurolite, in mappable zones of chlorite pseudomorphs.

## HIGH-ALUMINA SCHISTS OF THE HOOSAC FORMATION

The Hoosac Formation in western Massachusetts is a Proterozoic Z to Cambrian allochthon, isolated by Taconian thrust faults, that forms part of the eastern cover of the Berkshire massif. The rocks comprising the Hoosac Formation have been significantly affected by both the Taconian and Acadian orogenies and the rocks now reside in the zone of maximum overlap between these events. As shown on the Bedrock Geologic Map of Massachusetts (Zen *et al*., 1983) and described in some detail by Norton (1976) and more recently by Ratcliffe *et al.*

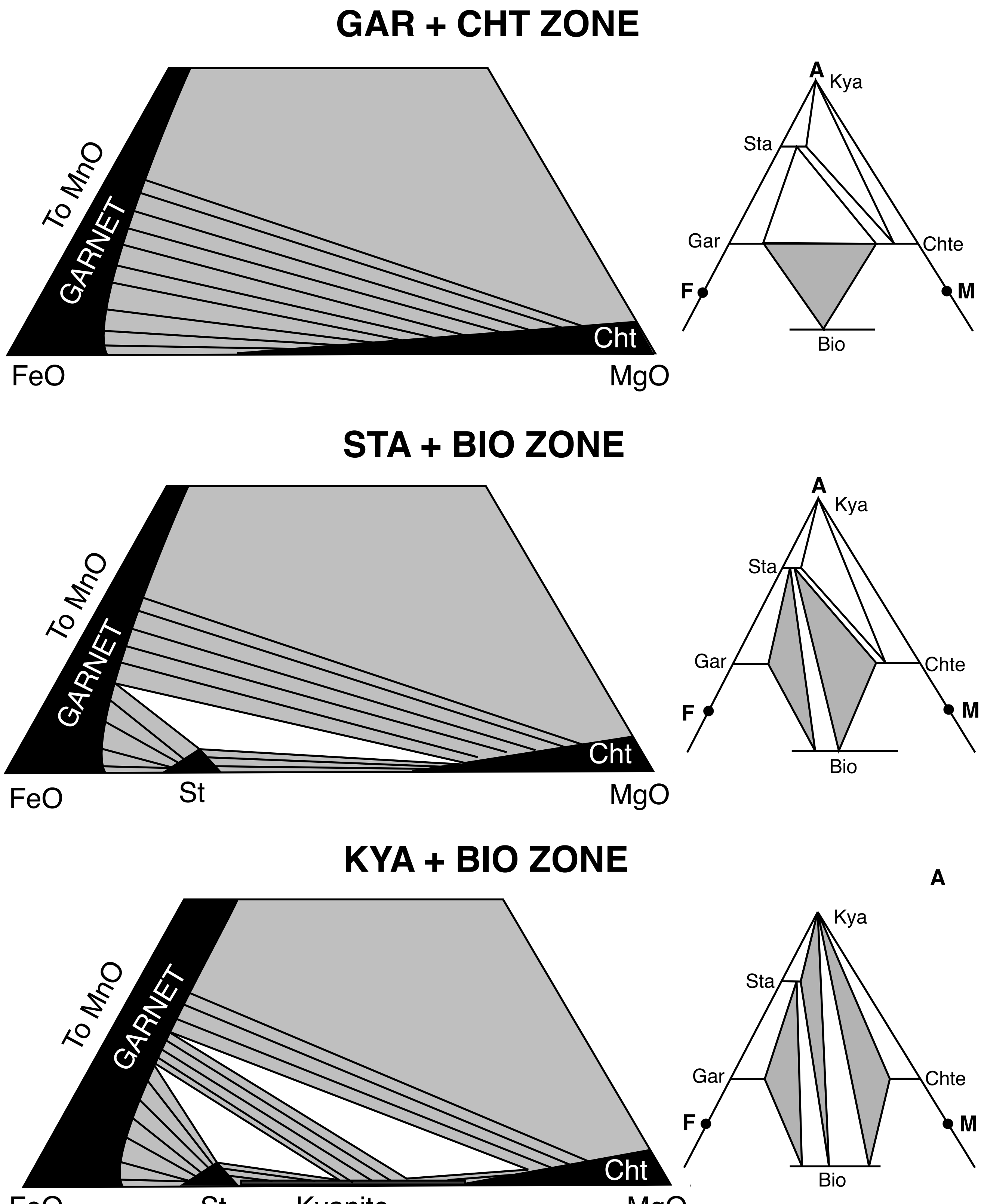


**FIGURE 3.** Schematic projections of phase relationships from "Biotite", Quartz, Muscovite, and $H_2O$ onto the FeO-MgO-MnO plane of the AKFM-Mn subsystem. AFM projections are shown for reference.

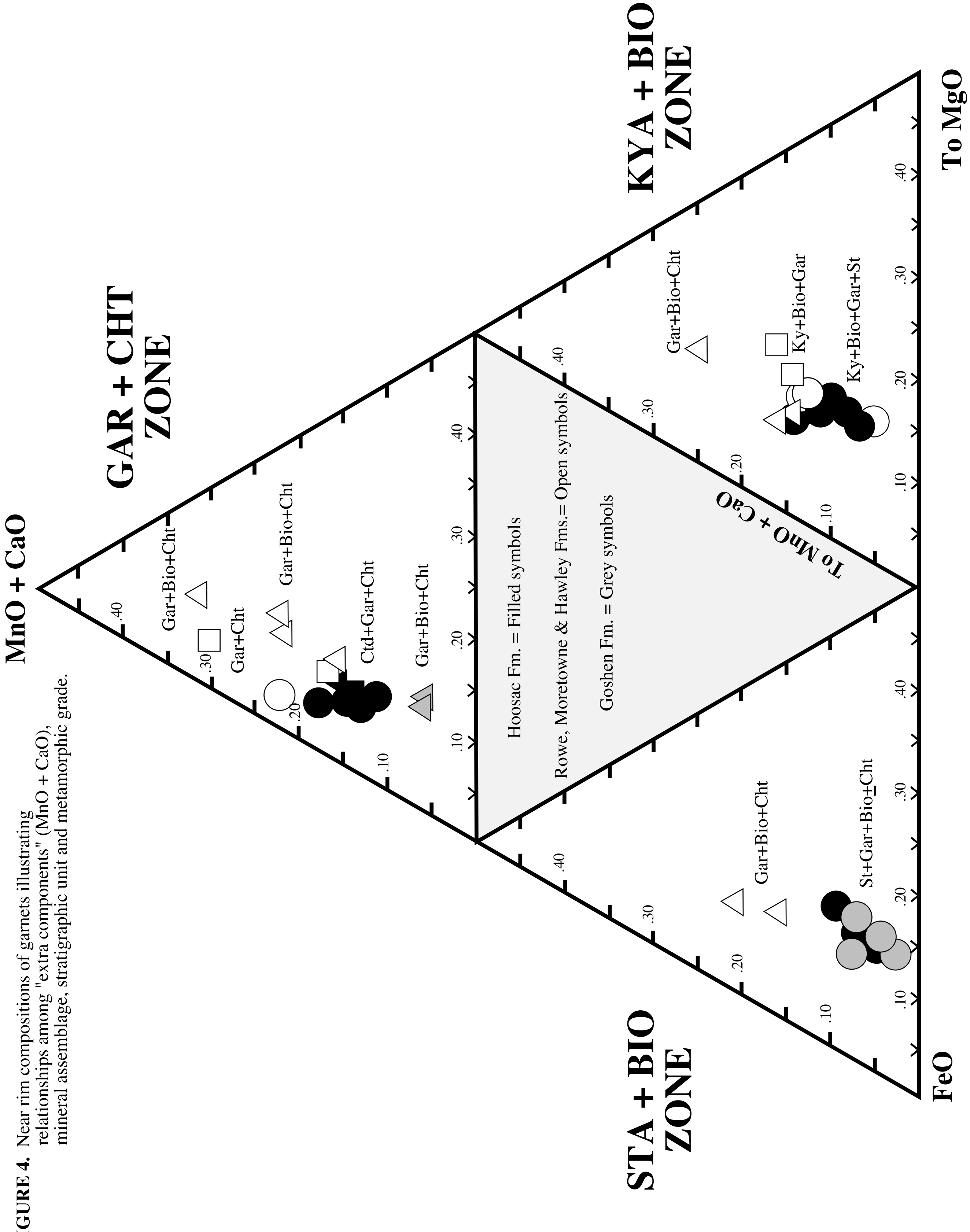


**FIGURE 4.** Near rim compositions of garnets illustrating relationships among "extra components" (MnO + CaO), mineral assemblage, stratigraphic unit and metamorphic grade.

(1988), the Hoosac formation can be divided into at least seven units. As observed by Norton (1976), most of the formation consists of "rather monotonous" grey to rusty, medium-grained Mus-Ab-Qtz schist to granofels that may include a variety of accessory minerals such as chlorite, biotite, garnet, staurolite, kyanite, and sillimanite, depending upon metamorphic grade and bulk composition. Of particular interest here are the high-alumina pelitic schists (CZhgt of Zen *et al.*, 1983) characterized by large (1 cm) garnets in a Qtz-Mus±Paragonite-rich matrix that extend in mappable bands from Vermont to near the Connecticut border. Even at the lowest metamorphic grade the overall coarse grain size of these rocks is striking. However, as pointed out by Norton (1976) and emphasized by Ratcliffe *et al.* (1988), there are several different high alumina lithologies mapped within the Hoosac Formation. Ratcliffe *et al.* (1988) suggest that the upper large garnet schist (CZhg of Zen *et al.*, 1983) may be equivalent to high-alumina compositions in the Rowe Formation (Pinney Hollow Formation in Vermont). The stratigraphically lower, big garnet (aluminous) unit (CZhgt of Zen *et al.*, 1983) has been correlated with the Gassetts schist in Vermont as indicated on the Bedrock Geologic Map of Massachusetts. The spatial extent of metamorphic zones (Figure 5), compositions of porphyroblasts, distribution of inclusions within garnet, and the compositional zoning of garnet from these aluminous rocks in Massachusetts are generally consistent with the prograde evolution of the Gassetts, Vermont location described by A.B. Thompson and co-workers (Thompson *et al.*, 1977a,b) as well as subsequent investigations on similar rocks in southeastern Vermont including those of Downie (1980, 1982), Crowley (1989), Karabinos (1984, 1985), Cook (1988), Cook and Karabinos (1988), and Giaramita and Day (1991).

**AFM Assemblages and Isograds**

The high-alumina Hoosac schists of western Massachusetts contain mineralogic and textural evidence of polymetamorphism. Compositionally-zoned megacrysts of white mica (phengite cores and muscovite rims) and, in rocks of appropriate grade, homogeneous and largely undeformed porphyroblasts of muscovite, staurolite, kyanite, biotite, chlorite, and chloritoid crosscut highly folded schistosities defined by phengitic muscovite and, in some rocks of appropriate grade, paragonite, chlorite, chloritoid, staurolite and kyanite. The mineral assemblages based upon the overprinting porphyroblasts are generally consistent with the four metamorphic zones that reflect an increase of metamorphic grade from north to south as shown on Figure 5. These isograds are very similar to those of the Metamorphic Map of Massachusetts (Zen *et al.*, 1983), except there is more detail shown here. For example, due to the restricted compositions of the rocks and detailed sample coverage it has been possible to separate the Mg/Fe-dependent Kyanite isograd from the Staurolite isograd.

The mineral assemblages of the Mus+Qtz-bearing schists are generally consistent with the AFM mineral assemblage diagrams of Figure 5. Because these rocks have mineral assemblages that reflect bulk compositions above the Gar+Cht join on the AFM projection, Zone I, the Garnet Zone, can be divided into three prograde "sub-zones": (Ia) Cht+Gar+Ctd; (Ib) St+Cht+Gar (with extra components)+Ctd; (Ic) St+Cht+Gar. Due to the lack outcrops in the critical area (see Figure 5), assemblage Ic rocks have not yet been observed. Although Zone II is the traditional Staurolite Zone defined on the basis of St+Bio compatibility, the "staurolite" isograd is actually a "biotite-in" isograd and biotite typically occurs only at the higher grade in high alumina rocks as textually late laths and in low modal amounts (<10%). The Kyanite Zone, Zone III, can also be divided in to two subzones, although some overlap exists due to the stabilizing effect of calcium in feldspar (see Cheney and Guidotti, 1979): (IIIa) Ky+Bio+Par and (IIIb) Ky+Bio+Pla. Zone IV, the Sillimanite Zone (Sil+Bio), as is typical in this terrane, is marked initially by rocks containing fibrolite with kyanite as discussed by Hames *et al.* (1991). The sillimanite isograd occurs in the Hoosac Formation south of the southern most occurrences of Gassetts like schist (Figure 5) and will not be considered further.

**Mineral Chemistry:**

The compositions of minerals from 15 samples of high-alumina rock as shown on Figure 5 have been determined by electron microprobe analysis. This data base typically consists of 50-100 point analyses of large (>1.0 cm) zoned garnets and 30-100 point analyses of complex white mica assemblages in addition to a minimum of 3-10 point analyses of most other minerals comprising each sample. Various aspects of the chemical data in conjunction with the petrographic work on some 150 Hoosac samples have been partially presented by Cheney *et al.* (1980) and Cheney (1980; 1986). Mineral composition data are summarized on Figure 6, a semi-log diagram (an Albee plot; see Albee, 1972) with the logarithm of compositional variables plotted along the X-axis against a Y-axis

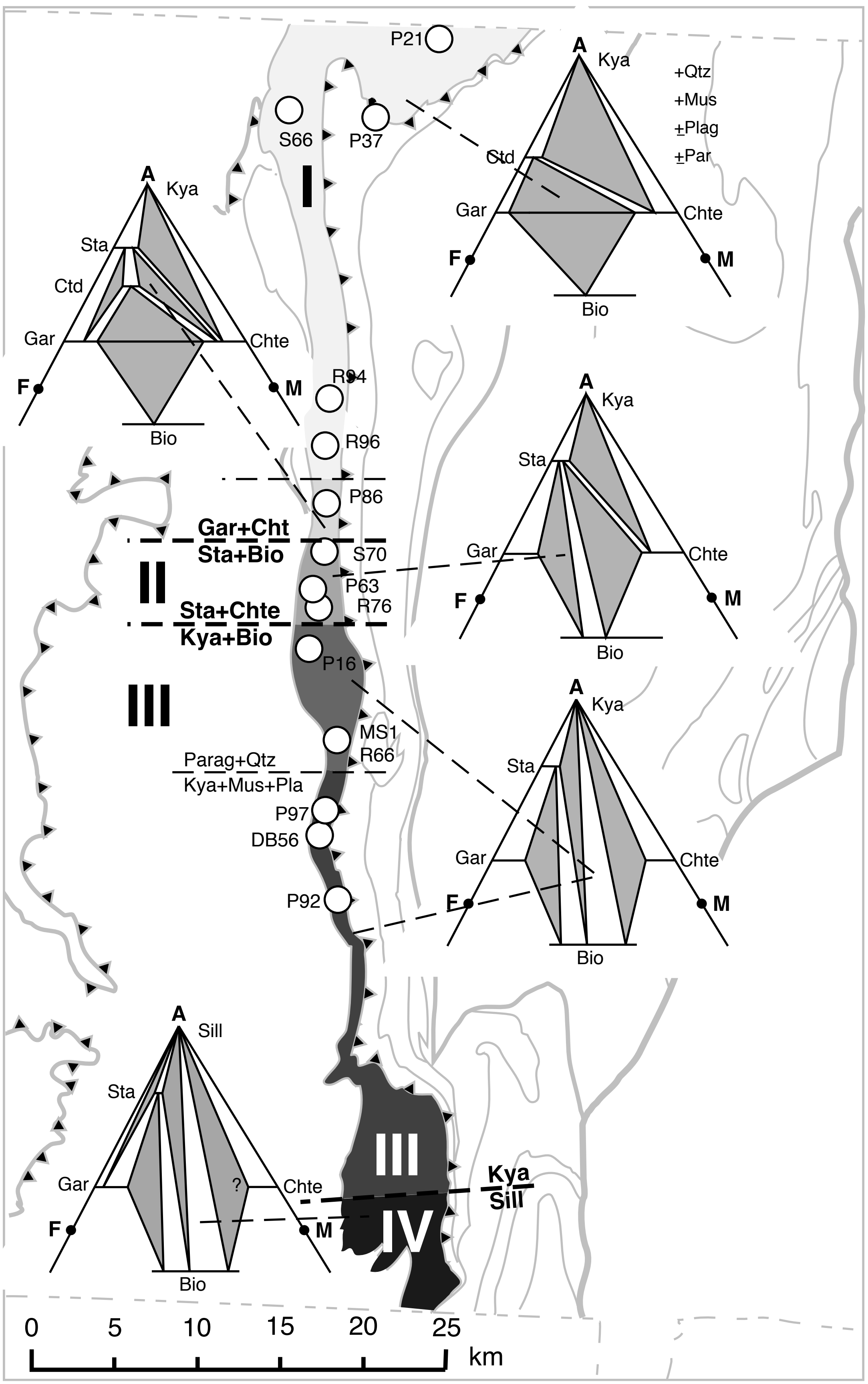


**FIGURE 5**. Metamorphic map for the Hoosac Formation showing the distribution of analyzed samples, metamorphic zones, and schematic AFM projections. The geology is as shown on figure 1.

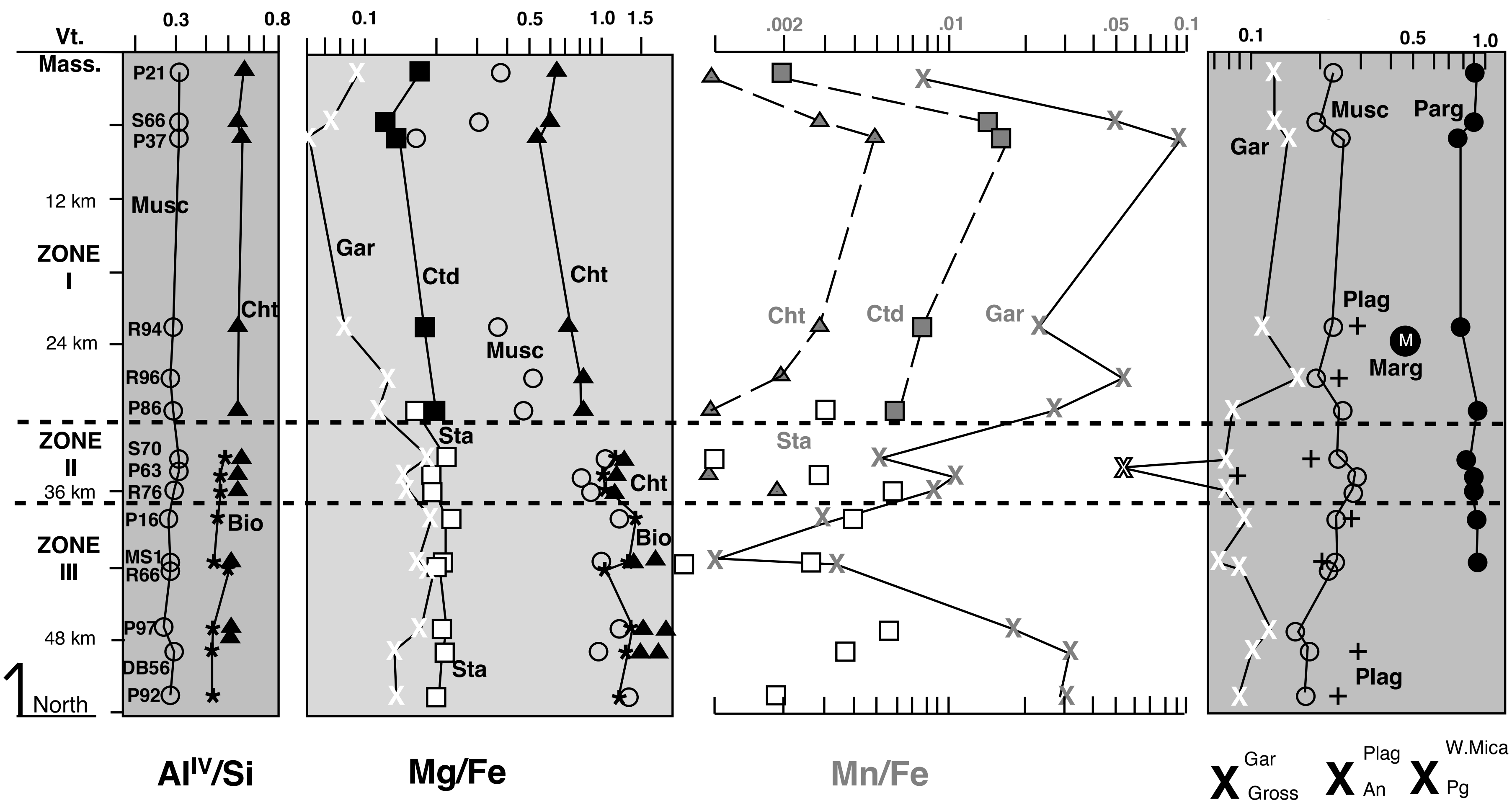


**FIGURE 6.** Semi-log diagram summarizing electron probe data for minerals from high-alumina schists of the Hoosac Formation. The logarithms of compositional variables (horizontal axis) are shown as a function of distance south from the Vermont border (vertical axis). The mineral assemlage for each sample plots along a horizontal line. As discussed by Albee (1972), the horizontal separation of two points (*e.g.* Mg/Fe) for a mineral pair is related to the Kd (*e.g.* $(Mg/Fe)^{Gar} / (Mg/Fe)^{Bio}$).

that records distance in kilometers south from the Vermont-Massachusetts border. These data are generally from fabric-cutting porphyroblasts and the compositions of most minerals change in a manner consistent with prograde evolution as observed in many terranes. Of particular note is that:

1) The Mg/Fe ratios of chloritoid and chlorite increase with increasing grade. The chlorite in some St+Bio Zone and higher grade samples clearly post-dates most of the other porphyroblasts and is “retrograde,” although other hypotheses have been advanced for similar chlorite occurrences in similar grade rocks by Karabinos (1984) in the Jamaica, Vermont area and Giaramita and Day (1991) at Gassetts, Vermont (compare Guidotti, 1974).

2) The Mg/Fe ratio of biotite increases with increasing grade. The Mg/Fe ratio of garnet increases from Zone I through Zone II and then decreases in the Kyanite Zone.

3) The element partitioning among phases ($K_D$), as indicated by the horizontal separation between the same ratio for different minerals, is generally systematic and consistent with prograde evolution. However, in detail the compositions of some porphyroblasts may reflect equilibration at different conditions during P-T-t evolution.

4) The Pg (paragonite) content of the muscovite porphyroblasts and megacryst rims increases from the Gar+Cht Zone (I) through the St+Bio Zone (II). Within the Ky+Bio Zone (III), the Pg content of muscovite attains a maximum of ~33% Pg, coincident with the disappearance of paragonite from the groundmass, and then decreases with further rise of grade.

5) Of particular interest is that the tschermak content of these muscovites, as shown by $Al^{IV}/Si$, is very nearly constant from the Gar+Cht Zone to the Ky+Bio Zone.

**Fabrics, Garnets and Multiple Events**

Relationships summarized heretofore suggest that muscovite, the other porphyroblasts, and some of the paragonite reflect a prograde metamorphism that was superimposed on a pre-existing-fabric (possibly Taconian). In most samples this fabric is defined by finer-grained laths of celadonitic (low-Na, low-Al) muscovite and even finer-grained laths of paragonite. Low grade rocks (Zone I) also have fine-grained laths of chloritoid and chlorite in these complexly folded fabrics. At higher grades (Zones II and III), the fabrics are defined primarily by white mica, although rare fine-grained staurolite and kyanite do occur aligned in the fabrics and may be deformed (broken /bent). These are most common in Zone II (St+Bio), just north of the initial occurrence of kyanite porphyroblasts.

Additional indications of an early event, superseded by a later event of similar grade, include the occurrence of garnets with unconformity textures similar to those described by Rosenfeld (1968, see also Rosenfeld *et al*., 1988). The Hoosac garnets from Massachusetts are remarkably similar in both appearance and chemical zoning (see Figure 7 for some representative zoning patterns) to unconformity garnets from high-alumina schists of the Hoosac Formation near Jamaica, Vermont described by Karabinos (1984). Karabinos suggested that two stages of garnet growth, separated by a retrogressive resorption event, are required to explain the chemical zoning that accompanies the overgrowth of inclusion-free rims on inclusion-riddled cores. The validity of this model has received recent support from the isotopic studies of Christensen *et al.* (1989), Chamberlain and Conrad (1991), and Young and Rumble (1992, in preparation). Moreover, multiple sizes of garnet porphyroblasts occur in many of these rocks as described by Bashir (1989) and Crowley (1989) in samples from southeastern, Vermont. In the Vermont occurrences, the smaller garnets have compositions similar to the rims from the larger garnets (Bashir, 1989). An additional complexity mandating caution in the interpretation of both optical and chemical data from large garnets is that some of the larger garnets appear to have originated from the coalescence of several smaller garnets and that other large garnets seem to have formed from the apparent fracturing of early garnets and subsequent annealing. Similar textures were reported by Crowley (1989) for garnets from the Gassetts schist and Pinney Hollow Formations of the Star Hill sigmoid in Cavendish, Vermont.

## Thermobarometry

Due to the small modal amounts of biotite in these rock, the use of biotite geothermometers is problematic at best due to the expected tie line rotation on cooling noted by Tracy *et al*. (1976). Two additional complexities are the chloritization effect and the garnet resorption effect reviewed by Spear (1989, 1991). Bearing in mind these problems, Figure 8 shows some remarkably consistent geobarometric results from all four of our Ky+Pla rocks. These results were obtained from an updated version (by P. Crowley) of the Hodges and Crowley (1985) calibration. Of interest is that when combined with the Ky+Bio stability curve of Spear and Cheney (1989), the resulting minimum pressures for Zone III rocks in this terrane are on the order of 8 kilobars for the crosscutting porphyroblast assemblages. These pressures are consistent with pressures of 7 to 10 kilobars obtained by similar methods from clearly Acadian minerals of the Goshen Formation in Western Massachusetts (Goeldner, 1983; Hudson, 1983) and southeastern Vermont (Davidow, 1989) as well as with the more recent work summarized in Hames *et al.* (1991) and Hickmott and Spear (1992, in press).

## Muscovite and Multiple Events

Textually complex white mica assemblages can be divided into at least three types: (1) foliation-defining laths of celadonitic muscovite and some paragonite, (2) crosscutting porphyroblasts (coarse lath and tablets) of high-Na normal muscovite (Si≈6.1 atoms/22 oxygens), and (3) compositionally-zoned megacrysts with celadonitic core and “normal” rim compositions (documented at least into Zone IIIB, see Figure 9). As shown on Figure 9 there is a remarkable range in the compositions of muscovites from these rocks that correlates with these textural habits. Moreover, as has been commonly observed (*e.g*. Guidotti, 1984; Dempster, 1992), the tschermak and paragonite contents of the white micas are apparently coupled in such a way that there is a systematic relationship between high sodium (paragonite component) and high-alumina (tschermak component) contents.

The compositional variation of zoned megacrysts and/or porphyroblasts and groundmass laths from individual samples define systematic paths characterized by decreasing celadonite and decreasing Mg/Fe ratio with increasing Na/K ratio on the muscovite plane of the AKFM tetrahedron (Figure 9). As developed by Thompson (1979), the AKFM composition of muscovite is buffered, at constant P-T-$\mu_{H2O}$, in three-phase AFM assemblages (*e.g*., Ky+St+Bio or Ctd+Cht+St). Hence, the composition of muscovite in these assemblages will vary in a predictable fashion and define paths on the muscovite plane of the AKFM tetrahedron that reflect variation in these intensive parameters. Muscovite compositional ranges are comparable to those discussed by Dempster (1992, and references therein) for normal (i.e. biotite-bearing) bulk compositions.

## TECTONIC IMPLICATIONS OF HOOSAC PETROLOGY

The observation that from Zone I through IIIb the tschermak content of the muscovite porphyroblasts remains relatively constant is of particular importance. Zone I contains the same matrix assemblage, Gar+Cht+Ctd, as the cores of many garnets. Thus, the garnets probably grew in this assemblage. However, the groundmass muscovite in nearly all rocks from this terrane, independent of “current” grade, has a very different composition than even the lowest grade muscovite porphyroblast. The data shown on Figure 9 clearly indicate that the groundmass phengitic muscovites and the muscovite porphyroblasts have formed at very different conditions. Based on the exploratory experimental work of Massone and Schreyer (1987), the phengitic micas must reflect either a temperature substantially lower than the Zone I mineral facies or pressures greater than those at which the muscovite porphyroblasts formed. Because the groundmass phengitic micas occur with other groundmass minerals consistent with at least the Zone I mineral facies, it is very plausible that the early event recorded by these rocks is a higher-pressure event than that recorded by the overgrowth assemblages. Thus, the core-to-rim compositional paths shown on Figure 9 generally reflect the prograde adjustment of lower T/higher P rocks to new metamorphic conditions. Additional support for this model includes the occurrence of irregular polycrystalline zones of plagioclase on the edges of some garnets, the sharp decrease in the grossular content in the outer rims of zoned garnets (see figure 7), and the restriction of rutile to the cores of these garnets. Ilmenite occurs in the garnet rims and it is the groundmass Ti -phase.

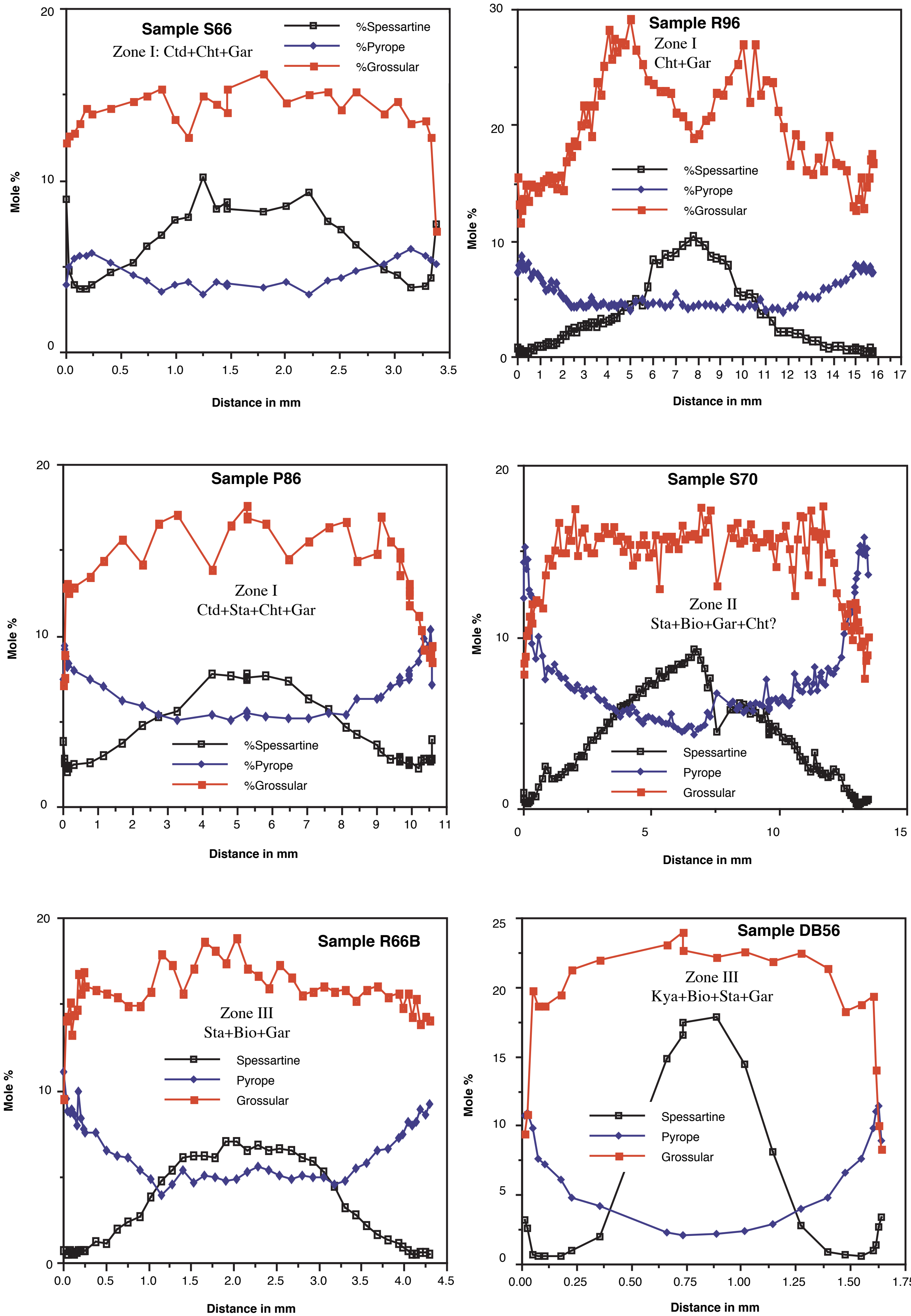


**FIGURE 7A.** Garnet zoning profiles for mole % spessartine, pyrope and grossular from representative Hoosac high-alumina schists. Almandine zoning for these same samples is shown on figure 7B.

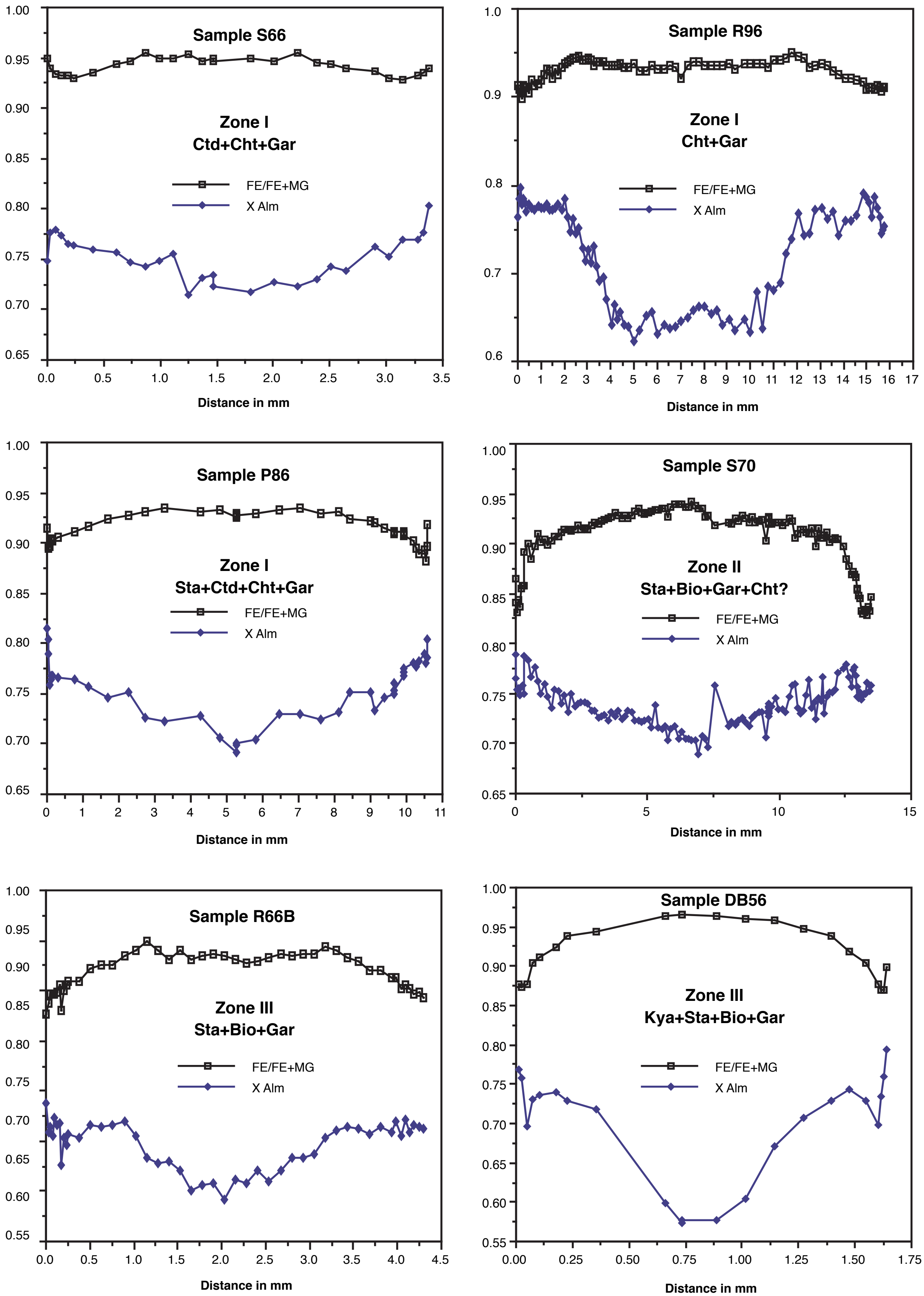


**FIGURE 7B.** Zoning profiles for the almandine mole fraction and Fe/Fe+Mg ratio from the same garnets as shown in figure 7A.

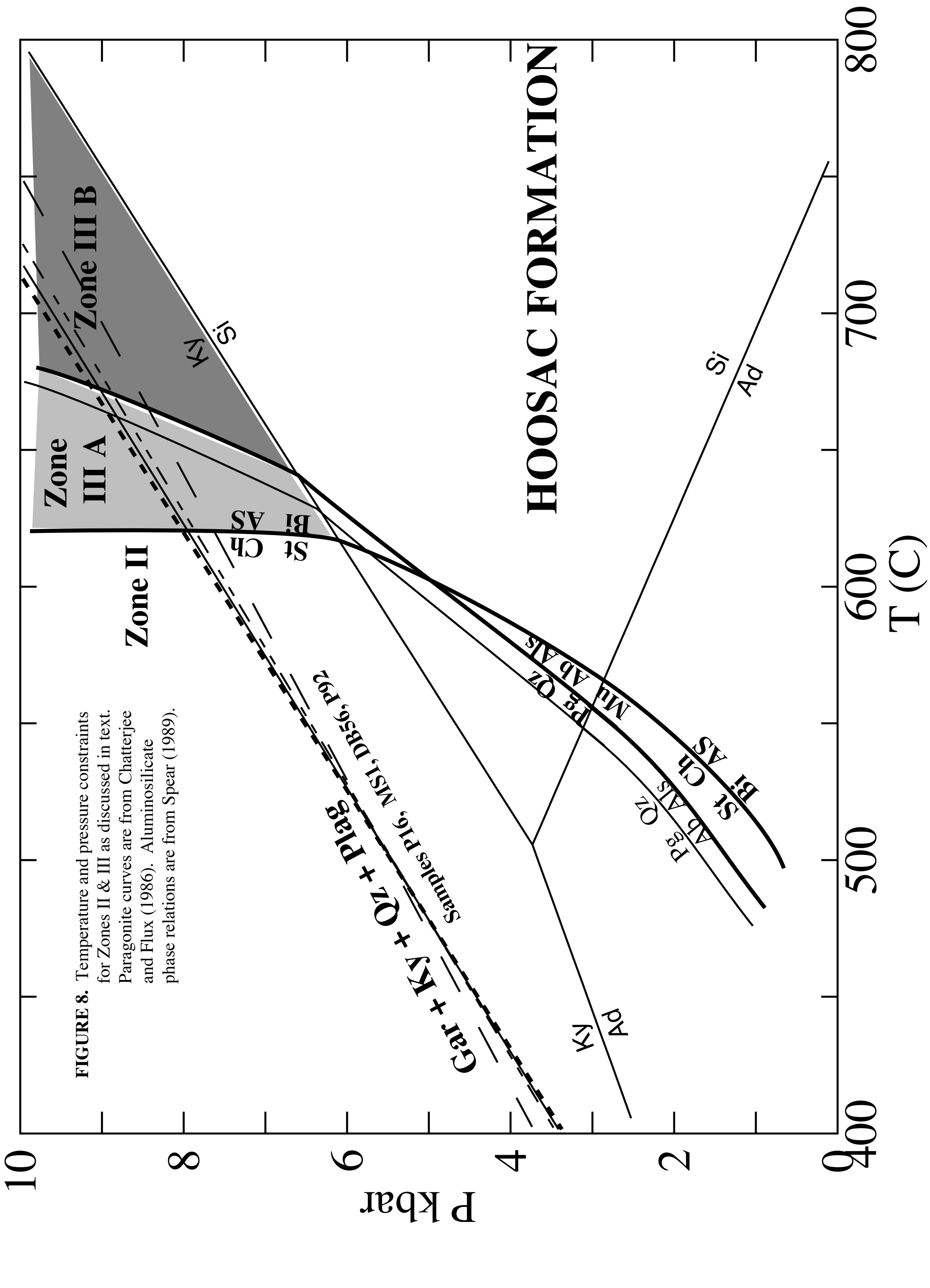


**FIGURE 8.** Temperature and pressure constraints for Zones II & III as discussed in text. Paragonite curves are from Chatterjee and Flux (1986). Aluminosilicate phase relations are from Spear (1989).

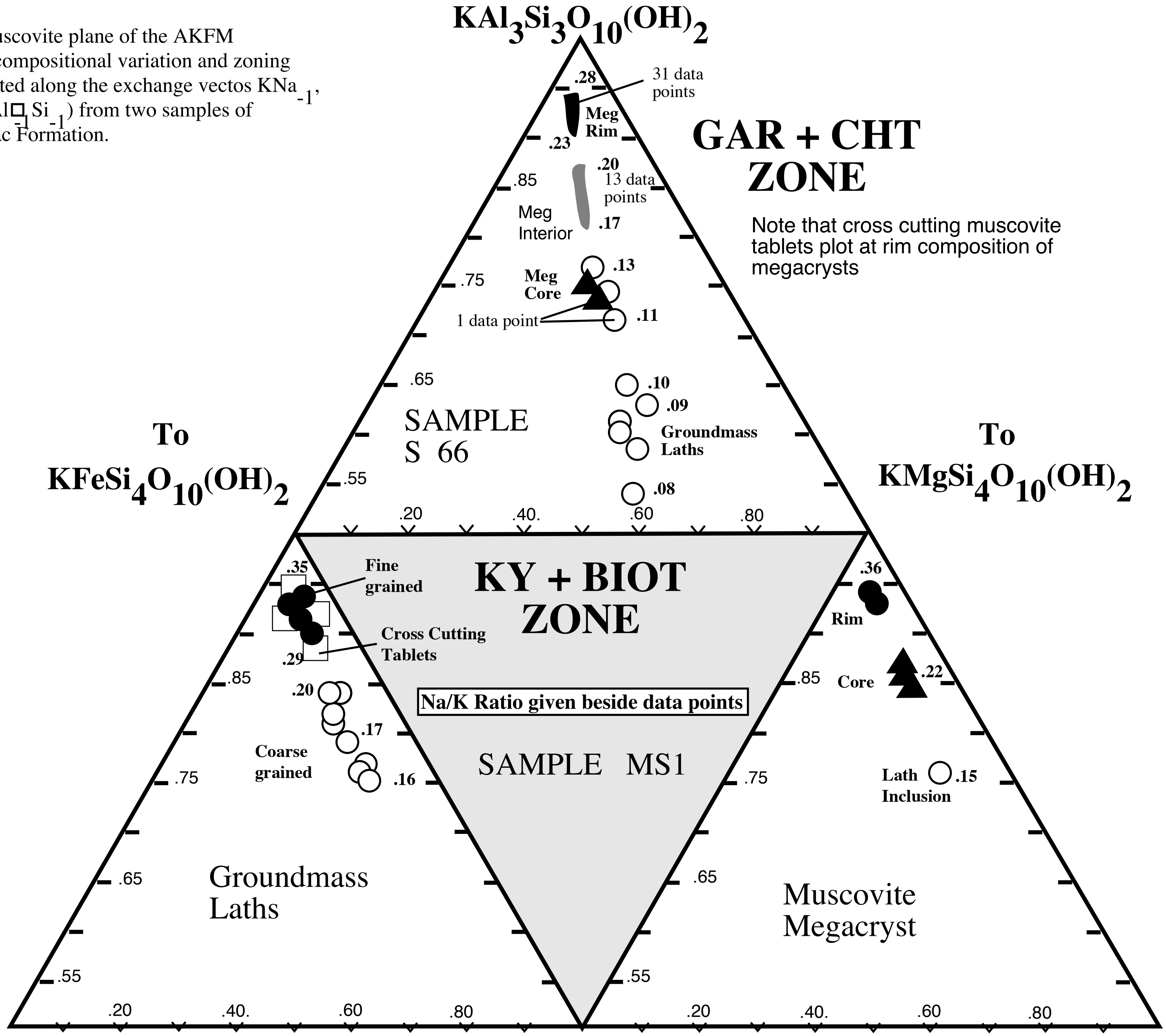


**FIGURE 9.** The muscovite plane of the AKFM tetrahedron and the compositional variation and zoning of muscovite (projected along the exchange vectos $KNa_{-1}$, $Al_2Ti_{-1}Fe_{-1}$, and $KAl\square_{-1}Si_{-1}$) from two samples of high- alumina Hoosac Formation.

There are two obvious models for this polymetamorphism: (1) Acadian overprint of an early Acadian terrane and/or (2) Acadian overprint of a Taconian terrane. Armstrong *et al.* (1992) have shown that the Acadian event recorded higher pressures (~12 kbars, maximum), by some 4 kilobars, than the Taconian event (~ 8 kbars, maximum) to the west of the Berkshire Massif. As pointed out to us by Karabinos (personal communication, 1992) this is in fact consistent with the allochthonous nature of the Hoosac rocks and with their source east of their current location. Because the Taconian subduction zone was probably east-dipping as shown by Stanley and Ratcliff (1985), rocks transported from the east during the Taconian orogeny could in fact reflect deeper burial, as is the apparent case. This of course implies that the Hoosac rocks were undergoing metamorphism or had already been metamorphosed at the time of thrusting. A similar conclusion is required to account for the high pressure "eclogitic" rocks of the Cannon Mountain Formation (Harwood, 1976, 1979; Maggs, 1984; Maggs *et al.*, 1986). However, bear in mind that although we have assembled an elegant mansion of cards, existing data do not preclude the possibility that the early event recorded in these rocks is Acadian, as Karabinos and Laird (1988) carefully point out. It is even possible that the early white mica assemblages in these rocks simply reflect very low temperatures and are recording the compression and early heating portion of a clockwise P-T-t loop in the sense of England and Thompson (1984).

Complex white mica assemblages have been observed so far only in high-alumina rocks from the Hoosac and Rowe Formations. Thus, discrimination among the polymetamorphic models requires additional data regarding the compositions of white mica from the low-alumina rocks of the Hoosac Formation and the Silurian-Devonian rocks from the east limb of the Berkshire massif. In short, the compositional variation of white micas from pelitic schists in western Massachusetts may help to discriminate between Taconian and Acadian events in the same way that complex amphibole assemblages from Cambrian-Ordovician meta-volcanic rocks of northern Vermont (*e.g.* Laird and Albee, 1981) and garnet zoning (Cook and Karabinos, 1988) have been used to look at possible Taconian metamorphic events through Acadian overprinting.

## ACKNOWLEDGEMENTS

Much of the work reported here was fostered by the interest and guidance of the field geologists who mapped the rocks. In particular we are indebted to the late Norm Hatch and the late Leo Hall for their curiosity, generosity and support. We are also thankful for the continued interest and support of Rolfe Stanley, Nick Ratcliff and Steve Norton. In addition we have benefitted from numerous stimulating and provocative exchanges about these rocks with many colleagues, in particular Peter Crowley, Liz Downie, Peewee Guidotti, Paul Karabinos, Peter Robinson, John Rosenfeld, Frank Spear, Walt Trzcienski, and Jim Thompson. Clearly the results summarized here represent, in part, the efforts of many former students who have worked with one or both of us over the years including, but not limited to Neena Bashir, Linda Boop, Aaron Britt, Deen Bryan, Dan Cohan, Jim Crowley, Joel Davidow, Liz Dibble, Carolyn Goeldner, Mark Handy, Don Hickmott, Mike Hudec, Sheila Hudson, Mark Sander, Mark Wick. Jackie Newberry cheerfully assisted with the preparation of the manuscript and Dick Stedman was turning out new thin sections from stop 9 yesterday. Financial support has been provided by NSF Grant 78-03636 to JTC, the Keck Foundation through the Keck Geology Consortium, Amherst College, and Smith College. In spite of all this help, mistakes remain and they are ours.

## ROAD LOG

We will assemble in the parking lot due north of the UMass football stadium and consolidate into a minimum number of vehicles for an 8:00 am departure. As shown on the route map for this trip, Figure 10, we will drive for approximately 1 hour and reassemble at the Bear Swamp Visitors' Center on River Road in Rowe. Proceed from the UMass parking lot west and north on MA 116 through Sunderland, across the Connecticut River, and north to the entrance on I-91 in South Deerfield. Take I-91 north to Greenfield and exit to follow MA 2 some 17 miles west to Charlemont. 1.5 miles west of the junction of MA 8A (south) and MA 2 in Charlemont, turn right (north) on Zoar Road. A rest area on the left and a blue sign for the Yankee Atomic Vistor Center signal the turn. Follow the main road 10.1 miles north through Monroe Bridge to the Bear Swamp Visitors' Center and its restrooms. From the parking lot at the Visitors' Center we will proceed north 3.6 miles to our first stop.

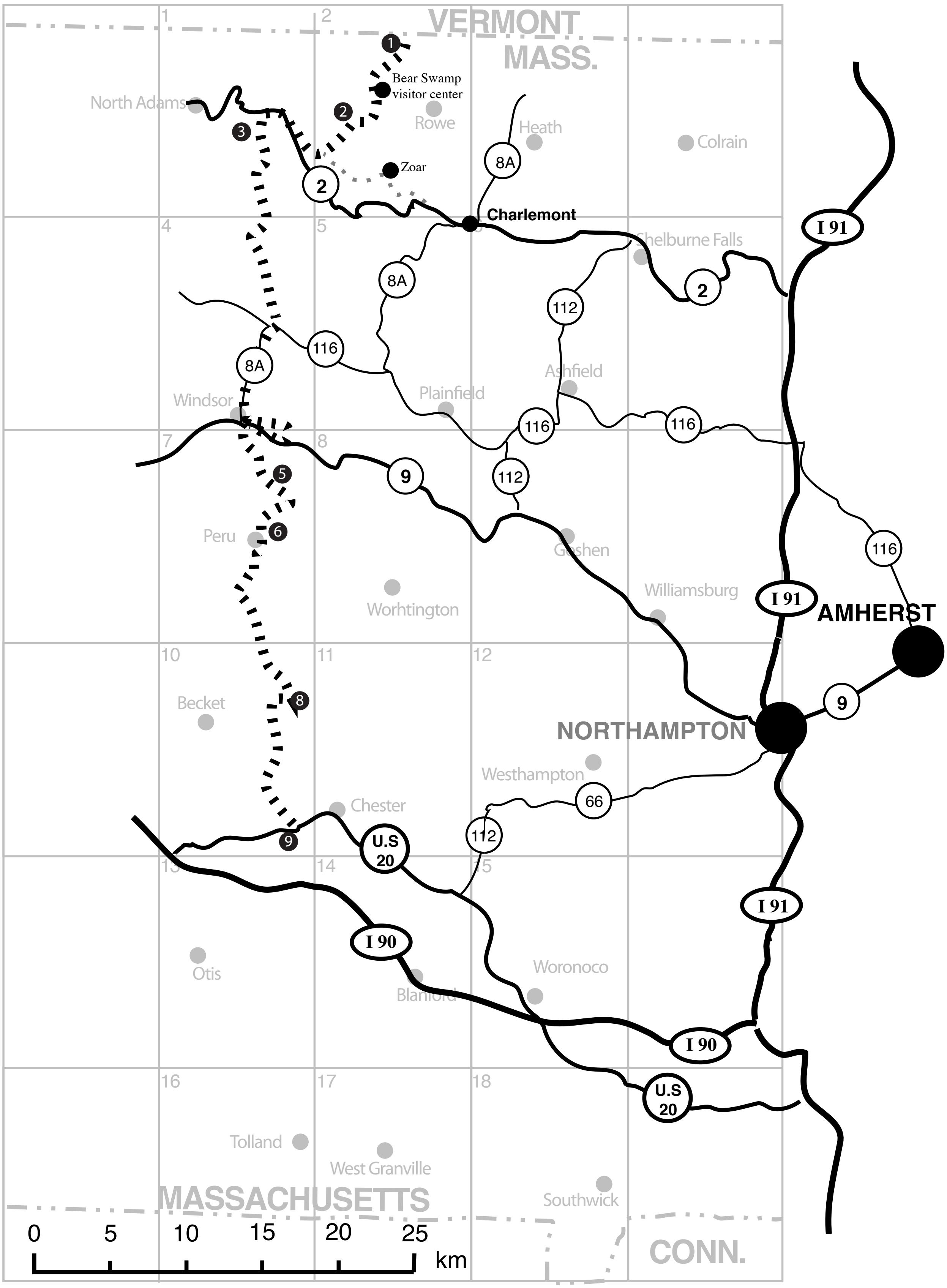


**FIGURE 10**. Field trip route and stop locations. Towns shown are for 7 1/2 minute quadrangles as indicated.

**Mileage:**

0.0 Road log begins at the pull-off on the west side of River Road, 0.4 miles north of turnoff to the dam for the now shut down Yankee Atomic Power Plant. Turn around and park heading south.

**STOP 1. BIG GARNET SCHISTS OF THE HOOSAC FORMATION** (30 MINUTES) (Rowe Quadrangle). The outcrops on the hillside to the west, under the power lines, consist of Cht+Gar+Mus+Qtz schists of the Hoosac formation that locally contain dark green, almost black, layers rich in chloritoid. The chloritoid-bearing rocks also contain paragonite. None of the seven samples from this outcrop examined petrographically contained biotite. Common accessory minerals include tourmaline, epidote/clinozoisite, rutile and or ilmenite, and locally magnetite. This is locality P21 on Figures 5 and 6. The garnets in some layers are very coarse-grained, despite the relatively low metamorphic grade indicated by the mineral assemblage. Moreover, the textural unconformity in these garnets can be seen with a hand lens as sharp rims on inclusion-riddled cores. Common garnet core inclusions are chloritoid, chlorite, very fine-grained rutile, quartz and less commonly white mica and/or epidote-group minerals. As is the case at Gassetts and other localities in S.E. Vermont, one can commonly distinguish two size fractions of white mica. The coarser-grained version that can be resolved into discrete grains is typically muscovite, whereas the much finer-grained variety tends to be paragonite.

0.0 Drive south on River Road.

0.4 On the left (east) is a road to the Yankee Atomic dam. The 186 MW Yankee Atomic Power Plant operated from 1960 until 1991. It was the third commercial nuclear power plant commissioned in the United States and the first in New England. Although this relatively small facility had an excellent safety record, the utilities that own it decided, amid controversy over the possible embrittlement of its steel confinement dome, that it would not be economic to continue operation and to seek the new license required when their original license expires in 1997. Decomissioning plans are being formulated now, but are not likely to be approved until the mid-1990's. Actual dismantling of the plant is unlikely to begin until at least 2000. One holdup on the process is the stock of highly radioactive spent fuel rods that is stored on site awaiting the completion of a national high-level waste repository.

1.0 Town center of Monroe Bridge. Continue south on River Road.

2.7 Monroe/Florida town boundary (yellow sign).

3.6 Bear Swamp Visitors' Center on left. The Bear Swamp Pumped-Storage Hydroelectric Station was built as a companion facility to the Yankee Atomic Power Plant. It is not easy or efficient to start and stop nuclear reactors, so the standard operating procedure is to run them continuously at full power. However, demand for electric power is episodic, matching the daily rhythms of people. When more power is available than is necessary to meet demand (usually at night), the Bear Swamp Station uses the excess power to pump Deerfield River water up to the Bear Swamp Reservoir. When demand for electric power exceeds supply (usually during the day), Bear Swamp Reservoir water is permitted to flow back through the pumps, turning them into electric generators, and down to the Deerfield River. The flow of the Deerfield River is, therefore, episodic and high flow rates can be expected for a few hours each day -- to the delight of white-water enthusiasts.

5.1 Park on right shoulder next to blasted cliffs, as far off the main road as possible, directly across from the gate to Lower Reservoir and the road to Bear Swamp Pump station. **Watch for falling rocks!**

**STOP 2. GARNET SCHISTS OF THE ROWE FORMATION** (30 MINUTES) (Rowe Quadrangle) This is locality P37 on Figures 5 and 6. The vertical surfaces of this blasted roadcut and the next roadcut to the south (locality P38) contain a variety of Rowe Formation lithologies that include a much finer-grained version of the aluminous mineral assemblages seen in the Hoosac Formation at Stop 1: Ctd+Cht+Gar+Mus+Par+Qtz phyllites. Also occurring at these outcrops are Gar+Cht+Mus+Qtz+Pla phyllites. Biotite or paragonite are common additions to the latter assemblage. Biotite and paragonite generally do not occur in the same rocks in this terrane until much higher grade. Additional rocks of interest from these outcrops are amphibole-bearing Gar-Cht-Mus-Qtz phyllites.

5.1 Continue south on River Road.

6.7 Crossing over the Boston and Maine Railroad tracks that lead to the Hoosac Tunnel (100 meters west). This tunnel runs for an amazing 7.6 km beneath the Hoosac Range. It was built at enormous expense, including nearly 200 human lives, between 1851 and 1875.

7.5 Whitcomb Hill Road. Turn right and follow this newly repaved road past fresh Rowe schist outcrops, past Church Road, past Monroe Road to a T-intersection with MA 2.

10.0 MA 2. Turn right and proceed west 1.8 miles west.

10.4 Whitcomb summit.

11.3 Olson Road (sign to Monroe).

11.8 Turn left onto the second road to the south after (west of) Olson Road. The first road to the south is a very sharp turn (120°). The second road south (Phelps Road) is a 90° turn and is unmarked, except by a stop sign. Proceed south 0.5 miles to where the road crosses the Cold River.

12.3 Just prior to the bridge pull off the road and park, on either side, as best you can. Walk back (north) along the road until you are upstream of the small waterfall (~50 meters) and then proceed west (left) to the outcrops creating the waterfall.

**STOP 3. "THE BEST GARNET-BEARING HOOSAC LOCALITY IN THE NORTH ADAMS QUADRANGLE."** (25 MINUTES) This locality (S66 of Figures 5 and 6), along with most of the other localities we have sampled in this area, was suggested by Nick Ratcliffe, who has mapped in the North Adams Quadrangle. The outcrops of Hoosac Formation along this stream are on strike with rocks of similar composition mapped as nearly-continuous lenses of high-alumina garnet schist south through the Windsor, Peru, and Becket quadrangles by Norton (1976 and references therein). A variety of mineral assemblages can be found at this location, ranging from "normal" Bio-Pla-Gar-Mus-Qtz phyllites through Gar-Cht-Pla-Pgt-Mus-Qtz phyllites to high-alumina Cht-Gar-Ctd-Qtz-Pgt-Mus phyllites. The biotite-bearing varieties generally contain very small garnets compared to the more aluminous bulk compositions. Of some interest is that many Bio+Pla-bearing Hoosac rocks contain garnets that have inclusions of chloritoid in their cores. This outcrop is also the home of some of the most strongly zoned muscovite "Megacrysts" yet analyzed in this terrane. Crosscutting muscovites here have cores with paragonite contents of ~10% whereas the discontinuous rims have paragonite contents of close to 25%!.

12.3 Continue south on Phelps Road.

12.4 Shaft Road, turn left.

13.3 The central air shaft of the Hoosac Tunnel for the Boston and Maine railroad.

14.0 Intersection. Turn right following Shaft Road and the brown sign pointing to Savoy State Forest.

14.6 Entering Savoy Mountain State Forest (brown sign).

15.3 North Pond picnic and swimming area on right. Restrooms in the summer.

16.9 Sharp left turn with (rough!) main road (now Burnett Road).

17.4 New State Road. The intersection is just past a large cleared area on the left (snowmobile parking). Turn right and continue south, into the Windsor quadrangle.

17.6 Tannery Road on your left.

18.3 Parking area on the right for Burnett Pond.

19.0 T-intersection with Adams Road. Turn left and head east.

19.1 Intersection. Turn sharply right with the pavement and follow Center Road south to MA 116.

22.0 T-intersection with MA 116. Turn right and proceed 0.5 miles east to junction with Rt. 8A.

22.4 This road cut was Stop 5 of Norton's (1975b) NEIGC trip.

22.5 Junction of MA 116 with MA 8A. Turn left on MA 8A and proceed south 4.3 miles to Windsor.

26.9 Intersection with MA 9. Turn left and drive east 0.6 mile.

27.5 Savoy Hollow Road. Turn left onto Savoy Hollow Road and drive north 0.2 mile.

27.7 Intersection with Shaw Road (sign on left for Cemetery Road). Turn right and drive east 0.8 miles to the height of land.

28.5 Stop and park at the top of the hill on this right-of-way through Notchview Reservation, owned by the Trustees of Reservations.

**STOP 4. GARNET SCHISTS AT THE NOTCHVIEW RESERVATION.** (30 MINUTES) (Windsor Quadrangle). Despite our drive south of some 16 miles, the large outcrops in the woods on both sides of the road are still in the "Garnet Zone" and contain the same range of assemblages as our last stop. Grain size, especially of the garnets is coarser and reminiscent of garnets from the same assemblages 25 miles to the north at Stop 1. Hence, for all practical purposes the metamorphic grade has not changed significantly since our first stop today!! Here we are between localities R94 to the north and R96 to the south as shown on Figures 5 and 6. Locality R94 is of particular interest as we have verified the occurrence of margarite with paragonite and muscovite (see Figure 6) in the matrix assemblage of this Ctd-Cht-Gar schist. We have also found, with the electron microprobe, a very minor amount of plagioclase (~An30) in this rock. The very fine-grained nature of the margarite coupled with the minor amount of matrix plagioclase makes their relationship unclear, but margarite has been commonly reported as an inclusion in garnets from Gassetts-like schists (*e.g.* Thompson *et al.*, 1986).

28.5 Continue east on Shaw Road 1.7 miles to its intersection with High Hill Street.
30.2 Intersection with High Hill Street. Turn right and proceed 0.4 miles to MA 9.
30.6 Junction with MA 9. Turn right and head west 3.1 miles to the Peru Road turnoff in Windsor.
32.8 Official entrance to Notchview Reservation on the right. Over 3000 acres of woods, fields, and trails make this property a great destination for hiking (see Brady and White, 1992) and especially cross-country skiing.
33.7 Intersection with Peru road (just east of the intersection of MA 8A north). Turn left and proceed south into the Peru quadrangle. The road becomes Beauman Road when you enter the town of Peru. Avoid this road during inclement weather as it degrades and has a tendency to become quite muddy and slippery when wet.
36.3 Major power line crosses road.
37.3 Stop and park cars as directed and then walk northeast through the upper end of a small clearing ~0.5 km to the steep northwest-trending ledges.

**STOP 5. STAUROLITE (FINALLY)-CHLORITOID-CHLORITE-GARNET SCHISTS FROM DEEP PERU.** (60 MINUTES) (Peru quadrangle). The spectacular, corrugated, coarse-grained nature of the garnet and quartz ribbons in the schists that make up the ledges obscure the fine-grained staurolite that occurs in the matrix with chloritoid, chlorite, paragonite, and muscovite. Although staurolite rarely exceeds 2% in the mode of these rocks, it has been identified in many of the 17 samples from this outcrop studied petrographically. We have not found kyanite in these high-alumina rocks (hence the large number of thin-sections) nor have we found the AFM assemblage St+Cht+Gar. This is locality P86 on Figures 5 and 6. The garnets here are sufficiently coarse that the textural unconformities are particularly well-developed in many samples from these outcrops.

37.3 Continue 0.7 miles southeast on Beauman Road to its intersection with East Windsor Road.
38.0 Y-junction with East Windsor Road. Turn right and follow the pavement to intersection with North Road.
39.9 Y-junction with North Road. Bear left and follow North Road south 1.1 miles to MA 143 in Peru.
41.0 Intersection with MA 143. Turn left and drive east on MA 143 for 0.7 miles.
41.7 Park on right (south) shoulder and proceed north, across road, and gently downhill to low outcrops in the Peru Wildlife Management Area.

**STOP 6. BIOTITE IN HIGH-ALUMINA COMPOSITIONS FROM DEEPER PERU.** (30 MINUTES) (Peru Quadrangle). These outcrops of Hoosac Formation contain St+Bio in Gar-Mus-Pgt-Qtz schists. Here the biotite is intergrown with coarse muscovite and it is difficult to see in most hand samples due to the small modal amount, typically less than 5%. This is locality S70 of Figures (5 and 6). Despite extensive searching, we have as yet to find rocks between Stop 5 and here that contain the AFM assemblage St+Cht+Gar. This assemblage is characteristic of Zone IC, which is "missing" in Peru -- probably due to the sparse outcrop in the critical area (note the swamp to our north).

41.7 After turning vehicles around, proceed west on Rt 143, back to the main intersection in the center of Peru.
42.4 North/South Road Intersection. Turn left and follow South Road 1.0 mile to where the road makes a sharp right turn.
43.4 Entrance to the Dorothy Frances Rice Wildlife Sanctuary. Turn left (almost straight) onto Rice Road and proceed 0.3 mile to end of road.
43.7 Park as appropriate. Dorothy Francis Rice was a 1923 graduate of Smith College who spent summers here as a child. When she died of tuberculosis in 1925, her family decided to create this sanctuary in her memory.

**STOP 7. HIGH-ALUMINA BIG GARNET SCHISTS FROM DEEPEST PERU.** (60 MINUTES) (Peru

Quadrangle). A color-coded map of the trails in the sanctuary is posted at the parking area. We will follow the pink trail clockwise beginning with the path that leads south, just to the left of the stone well. The pink markers are hard to see because they are positioned for a counterclockwise loop, but the path is well-worn. Follow the trail up and along the south slope of French Hill, ~0.75 km, to the point where the trail turns sharply downhill and south. Proceed a few dozen meters further south to a west-directed overlook. Now proceed due east into the brush. Outcrops in this area are coarse-grained Bio-St-Gar-Mus-Pgt schists. Plagioclase occurs in many of these rocks. It is likely stabilized with paragonite by calcium. Of particular interest here is that many of the samples from the east side of French Hill contain a fine-grained, fabric-aligned, commonly-deformed generation of staurolite and even kyanite, in rare cases. However, only staurolite occurs here as second-generation, coarser-grained, crosscutting porphyroblasts in a biotite-poor matrix dominated by white micas. These outcrops are just south of the P63 locality and near the R76 locality of Figures 5 and 6. Moreover, the intercalated sequence of gneisses and schists we passed along the trail are discussed as Stop 6 by Norton (1975b). Return due west to the "pink trail" and retrace the route back to the vehicles. This trail is one of 50 in Massachusetts recommended for pleasure hiking by Brady and White (1992).

43.7 Drive west back along Rice Road to South Road.
44.1 Intersection with South Road. Turn left and follow South Road 1.5 miles south to Middlefield Road.
45.1 Turn sharply right and then turn sharply left staying on South Road.
45.6 Intersection with Middlefield Road. Bear left and follow Middlefield Road 5.2 miles to the village of Middlefield.
47.8 Middlefield Town line.
50.8 Middlefield Village. Park on the right at the Town Hall and walk due west to low pavement outcrops behind the playground and in the woods beyond.

**STOP 8. THE KYANITE + BIOTITE ZONE AND THE MIDDLEFIELD THRUST.** (30 MINUTES) (Becket quadrangle). This is location MS1 and R66 of Figures 5 and 6. These outcrops contain coarse-grained Bio+St assemblages in coarse-grained Gar-Mus-Pgt-Qtz schists that are locally intercalated with less common but relatively coarse-grained, kyanite-bearing versions of this same assemblage. Hence we are at Ky+Bio grade. This is the highest grade occurrence of paragonite that we have so far confirmed. To the south, the aluminous rocks of Zone IIIB contain Ky+Pla and are apparently above the terminal stability of paragonite. As shown on Figure 7, sample MS1 also contains zoned muscovite megacrysts, similar to those observed in lower-grade rocks. This locality was Stop 8 of Norton (1975b) and is the home of the Middlefield thrust.

50.8 Turn around and drive north 0.1 mile.
50.9 Town Hill Road. Turn left and proceed downhill west and then south on Town Hill Road 7.7 miles through Bancroft to US 20 in Becket.
52.0 Sharp bend left.
54.5 Arched Penn Central railroad underpass just before a bridge over the Westfield River to the village of Bancroft.
57.7 T-junction. Follow the main (Bancroft) road left.
58.6 Intersection with US 20. Turn sharply right and drive 0.4 mile uphill to Quarry Road.
59.0 Quarry Road. Park or turn around here being watchful of fast-moving vehicles on US 20. Walk downhill along MA 20 to newly-created (1992) outcrops.

**STOP 9. VERY COARSE-GRAINED KYANITE-STAUROLITE-GARNET-SCHISTS.** (20 MINUTES) (Becket Quadrangle). This is our last stop, just north of locality P92 on Figures 5 and 6. The rocks contain particularly fresh, coarse-grained aluminous minerals (for all of you with little faith) and are especially rich in kyanite. Just as at our first stop, however, the inclusion assemblage in the cores of the garnets is Ctd+Cht. There is staurolite and even kyanite in the outer part of some of these garnets. We have even encountered rare biotite inclusions in the rims of a few garnets from locality P92.

**TO RETURN TO AMHERST:** As shown on figure 10, proceed east on US 20 for 8.9 miles through Chester to Huntington where you should turn left on MA 112 north and east across the river. Follow MA 112 for 3.4 miles to the junction with MA 66. Turn right onto MA 66, which will take you in 13.4 miles to MA 9 in Northampton.

Turn right and follow MA 9 east to Amherst and the Banquet!

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